Fisheries and Oceans Canada | Pêches et Océans Canada
Ecosystems and Oceans Science | Sciences des écosystèmes et des océans

Canadian Science Advisory Secretariat
Newfoundland and Labrador Region | Science Response 2016/013

STOCK STATUS UPDATE OF NORTHERN AND STRIPED SHRIMP IN SFAS 4, 5 AND 6

Context

The Zonal Peer Review (ZPR) for Northern Shrimp (*Pandalus borealis*) in Shrimp Fishing Areas (SFAs) 2-6 and for Striped Shrimp (*Pandalus montagui*) in SFAs 2-4 takes place biennially, in odd numbered years. In even years, updates on the status of Striped Shrimp and the key indices of the Precautionary Approach (PA) framework for Northern Shrimp in SFAs 2-6 are requested by Fisheries and Oceans Canada (DFO) Resource Management to inform management considerations.

This Science Response Report results from the Science Response Process of February 16, 2016 for the Stock Status Update of Northern and Striped Shrimp in SFAs 4, 5 and 6. The last full assessment of Divisions 2G-3K (SFAs 4-6) Northern and Striped Shrimp took place at the February 17-23, 2015 ZPR. Science Advisory Report 2015/018 was published as a result of the ZPR. Science Advice for the Eastern and Western Assessment Zones (SFAs 2-3) is performed, and published, through the Central and Arctic Region of DFO.

Background

Stock status indicators for *Pandalus borealis* in SFAs 5 and 6 were evaluated based on trends in catch from the Canadian Atlantic Quota Report (CAQR), fishable biomass and female spawning stock biomass (SSB) indices from DFO fall multi-species bottom trawl surveys in Northwest Atlantic Fisheries Organization (NAFO) Divisions 2HJ3K (SFAs 5 and 6). Stock status indicators for *Pandalus borealis* and *Pandalus montagui* in SFA 4 were evaluated based on catch, fishable biomass and SSB indices from a Northern Shrimp Research Foundation (NSRF) summer shrimp survey in NAFO Division 2G (SFA 4). Exploitation rate indices, calculated using catch and the fishable biomass index, were also utilized.

The Integrated Fisheries Management Plan (IFMP) PA framework was applied using an Upper Stock Reference (USR = 80% of the geometric mean of female SSB over a productive period) and a Limit Reference Point (LRP = 30% of the geometric mean of female SSB over a productive period) superimposed upon the exploitation rate trajectory over time. Due to differences in survey history, the respective productive time periods were taken to be 1996-2003 for SFA 6, 1996-2001 for SFA 5 and 2005-09 for SFA 4.

Analysis and Response

SFA 6 (Hawke Channel and NAFO Division 3K) *Pandalus borealis*

Fishery

The SFA 6 Northern Shrimp fishery began in the late 1970s; catches and total allowable catches (TACs) increased through the mid-1990s to mid-2000s primarily due to the development of a small vessel fishery. The resource began showing signs of decline in 2009,

Canada

initiating a reduction in TAC and, consequently, in catch. The reported catch, as of February 10, 2016 CAQR, for the 2015/16 fishing season was 44,262 t, 92% of the 48,196 t TAC (Figure 1). It is anticipated that the 2015/16 TAC will be taken.

Biomass

The fishable biomass index for 2015 was 138,000 t and the female SSB index was 89,000 t (Figures 2 and 3, Table 1). These represent declines of 41% and 35%, respectively, from 2014. Both indices are at the lowest levels in their time series, both well below their long term mean.

Exploitation

The exploitation rate index averaged 13% from 1997 to 2013/14, with the 2015/16 index between 19% and 21%, depending on how much of the TAC is taken (Figure 4).

Current Outlook

Female SSB, at its lowest level in the time series, was assessed to be below the midpoint of the cautious zone, with an 20%[1] chance of being in the critical zone, within the IFMP PA framework (Figure 5). The IFMP states that the exploitation rate should not exceed 15% given the current female SSB index of 89,000 t. If the TAC of 48,196 t were maintained and taken in the 2016/17 management year, the exploitation rate would increase to 35%.

SFA 5 (Hopedale and Cartwright Channels) *Pandalus borealis*

Fishery

The SFA 5 Northern Shrimp fishery began in the mid-1970s; catches and TACs remained relatively low until the mid-1990s. TACs were increased in the mid-1990s and again in the early 2000s and have remained relatively stable since. Commercial catch has followed the same trend. The reported catch, as of February 10, 2016 CAQR, for the 2015/16 fishing season was 20,117 t, 86% of the TAC (Figure 6). It is anticipated that the 2015/16 TAC will be taken.

Biomass

The fishable biomass index for 2015 was 148,000 t and the female SSB index was 83,000 t (Figures 7 and 8, Table 2). These represent increases of 3% and 20%, respectively, from 2014. Both indices are at levels close to the long term average.

Exploitation

The exploitation rate index varied without trend around 15% from 1997 to 2015/16, with the 2015/16 index between 14% and 16%, depending on how much of the TAC is taken (Figure 9).

Current Outlook

Female SSB was assessed to be in the healthy zone within the IFMP PA framework (Figure 10). If the TAC of 23,300 t were maintained and taken in the 2016/17 management year, the exploitation rate would be 16% in 2016/17.

[1] Erratum: May 2016. PA Reference points revised from previous assessment in accordance with refinements in biomass estimation method (11% now reads 20%).

SFA 4 (NAFO Division 2G) *Pandalus borealis*

Fishery

The SFA 4 Northern Shrimp fishery began in the late 1970s; however catches and TACs were very low until the late 1980s. Since then, TACs have been increased regularly and are normally fully taken. The reported catch, as of February 10, 2016 CAQR, for the 2015/16 fishing season was 15,065 t, 101% of the TAC (Figure 11).

Biomass[2]

Unlike further south, the survey that is used to estimate biomass indices in SFA 4 is conducted during the fishing season. The fishable biomass index for 2015 was 91,000 t and the female SSB index was 58,000 t (Figures 12 and 13, Table 3). These represent decreases of 13% and 18%, respectively, from 2014. The fishable biomass index is at the second lowest level in the eleven year time series and the female SSB index is at the third lowest level.

Exploitation[3]

Exploitation is defined as the fraction of beginning-of-season biomass removed by the fishery. Because there is no beginning-of-season biomass survey, all that can be computed is an exploitation rate proxy, namely the fraction of mid-season biomass removed. The exploitation rate index varied between 8% and 14% from 2007/08 to 2014/15 and the 2015/16 index is at 16.5% (Figure 14). This estimate will increase if the TAC is exceeded further.

Current Outlook

Female SSB was assessed to be in the healthy zone within the IFMP PA framework (Figure 15) with a 40%[4] chance of being in the cautious zone in 2015/16. At the time of the stock-status update, there is no mid-season biomass estimate for the upcoming fishing season; therefore its exploitation rate proxy cannot be computed.

SFA 4 (NAFO Division 2G) *Pandalus montagui*

Fishery

Striped shrimp (*Pandalus montagui*) is taken as by-catch in the Northern Shrimp fishery. A by-catch quota of 4,033 t was established beginning in the 2013/14 fishing season. Catch, as taken from logbook records, increased from 280 t in 2008 to 4,700 t in 2012 and declined to 1,200 t in 2014. The reported catch as of February 10, 2016 CAQR for the 2015/16 fishing season was 2,135 t, 53% of the by-catch quota (Figure 16).

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[2] Erratum: May 2016. Due to inadvertent omission of fishable-sized shrimp, and also due to estimating the biomass over an area larger than both the area fished and the area surveyed, these numbers have been updated. (73,000 t now reads 91,000 t, 70,000 t now reads 58,000 t, 42% now reads 13%, 17% now reads 18% and the word "second" was inserted).

[3] Erratum: May 2016. For the same reasons as footnote 2, 6% now reads 8%, 12% now reads 14% and 21% now reads 16.5%.

[4] Erratum: May 2016. Along with the changes noted in footnote 2, the PA reference points were updated based on refinements to biomass estimation methods. 22% now reads 40%.

Biomass[5]

The fishable biomass index for 2015 was 47,000 t (Figure 17, Table 4), representing a 52% increase since 2014. The index is above the long term mean. There is no accepted female SSB index for *Pandalus montagui* in SFA 4 (DFO 2015).

Exploitation[6]

The exploitation rate is between 5% and 9%, depending on how much of the by-catch limit is taken (Figure 18).

Current Outlook

There is no IFMP PA framework for this resource. If the by-catch limit is taken, the exploitation rate index will be less than 15% in 2015/16.

Conclusions[7]

SFA 6 (Hawke Channel and NAFO Division 3K) Northern Shrimp (*Pandalus borealis)*

- The resource is currently close to the LRP, in the cautious zone of the PA framework, with an 20% chance of being in the critical zone in 2016/17.
- Biomass indices (fishable and female SSB) are at the lowest levels in the survey time series.
- If the current TAC were maintained and taken in the 2016/17 management year, the exploitation rate index would be 35%. This is well above any previous estimate for this resource.

SFA 5 (Hopedale and Cartwright Channels) Northern Shrimp (*Pandalus borealis)*

- The resource is currently in the healthy zone of the PA framework.
- Biomass indices (fishable and female SSB) have remained relatively stable throughout the survey time series.
- If the current TAC were maintained and taken in the 2016/17 management year, the exploitation rate index would be 16%.

SFA 4 (NAFO Division 2G) Northern Shrimp (*Pandalus borealis*)

- The resource is currently in the healthy zone of the PA framework with a 40% chance of being in the cautious zone.
- Biomass indices (fishable and female SSB) have decreased to almost the lowest levels in the survey time series.

[5] Erratum: May 2016. Due to inadvertent omission of fishable-sized shrimp, and also due to estimating the biomass over an area larger than both the area fished and the area surveyed, these numbers have been updated. (31,000 t now reads 47,000 t and 3% decrease now reads 52% increase).

[6] Erratum: May 2016. Due to inadvertent omission of fishable-sized shrimp, and also due to estimating the biomass over an area larger than both the area fished and the area surveyed, these numbers have been updated. (7% now reads 5% and 13% now reads 9%).

[7] Erratum: May 2016. Conclusions updated as per changes in document.

- The exploitation rate index, for 2015/16, is 17% and the TAC has been exceeded. The exploitation rate index will increase if the TAC is exceeded further.

SFA 4 (NAFO Division 2G) Striped Shrimp (*Pandalus montagui*)

- There is no PA framework in place for this resource. If the by-catch limit is taken, the exploitation rate index will be less than 15% in 2015/16.
- The fishable biomass index is close to the highest level in the time series.

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Approved by

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DFO

February 17, 2016

Sources of Information

DFO. 2007a. Assessment Framework for Northern Shrimp (*Pandalus borealis*) off Labrador and the northeastern coast of Newfoundland; 28-30 May 2007. DFO Can. Sci. Advis. Sec. Proceed. Ser. 2007/034.

DFO. 2007b. Integrated Fisheries Management Plan: Northern Shrimp – Shrimp Fishing Areas (SFAs) 0-7 and the Flemish Cap.

DFO. 2009. Proceedings of the Precautionary Approach Workshop on Shrimp and Prawn Stocks and Fisheries; November 26-27, 2008. DFO Can. Sci. Advis. Sec. Proceed. Ser. 2008/018.

Orr, D., and Sullivan, D. 2013. The February 2013 assessment of Northern Shrimp (*Pandalus borealis*) off Labrador and Northeastern Newfoundland. DFO Can. Sci. Advis. Sec. Res. Doc. 2013/055. vii + 144 p.

DFO. 2015. Assessment of Northern Shrimp (*Pandalus borealis*) in Shrimp Fishing Areas 4-6 (NAFO Divisions 2G-3K) and of Striped Shrimp (*Pandalus montagui*) in Shrimp Fishing Area 4 (NAFO Division 2G). DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2015/018.

Appendix 1: Figures

SFA 6 (Hawke Channel and NAFO Division 3K)

Figure 1. SFA 6 historical Northern Shrimp catches and TACs for the period 1976-2015/16 (2015/16 catches are preliminary as of February 10, 2016). In 2003 the management year changed from a calendar year to a fiscal year.

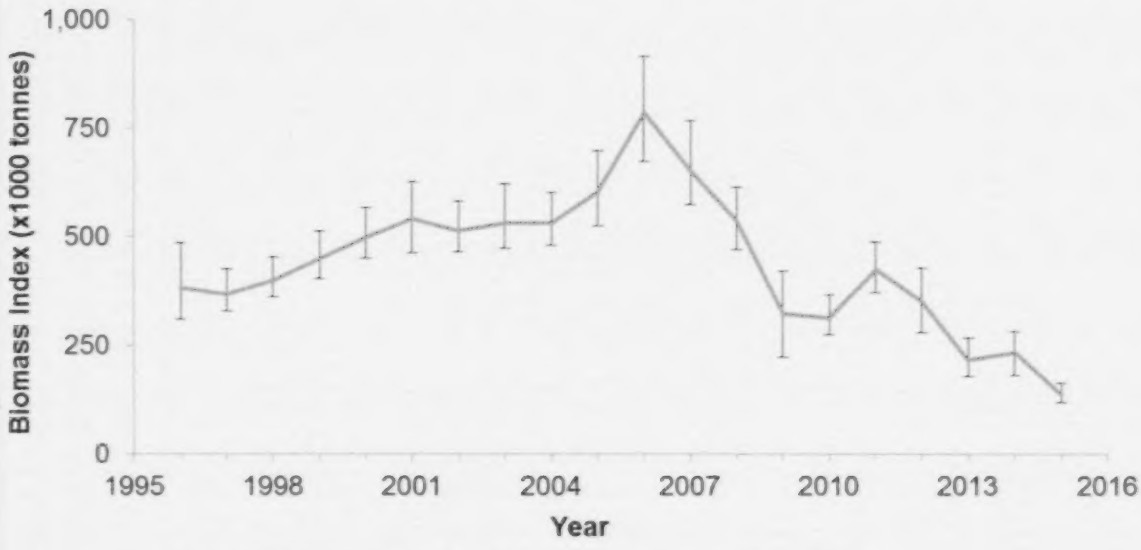

Figure 2. SFA 6 fishable biomass index. Error bars indicate 95% confidence intervals.

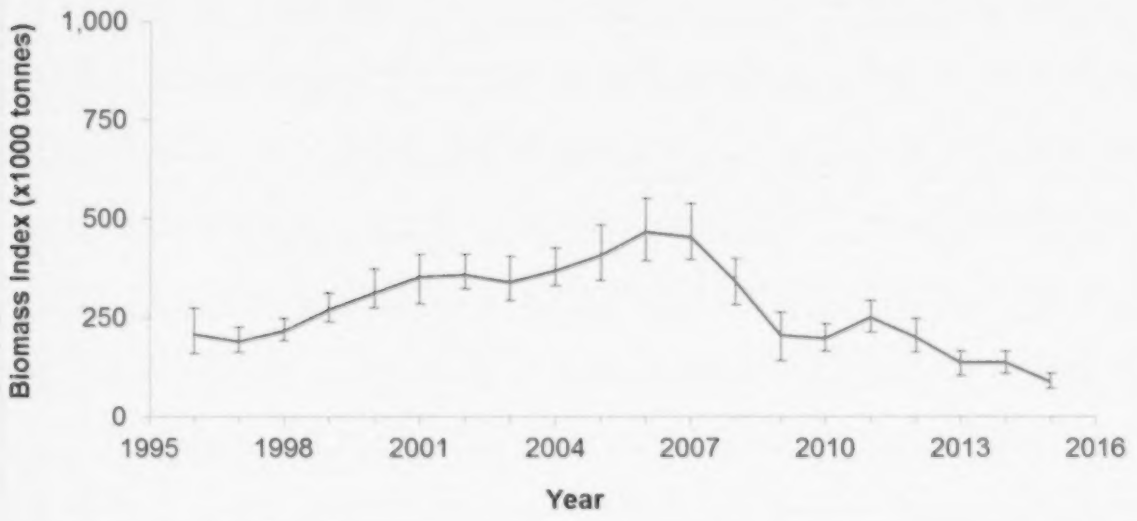

Figure 3. SFA 6 female SSB index. Error bars indicate 95% confidence intervals.

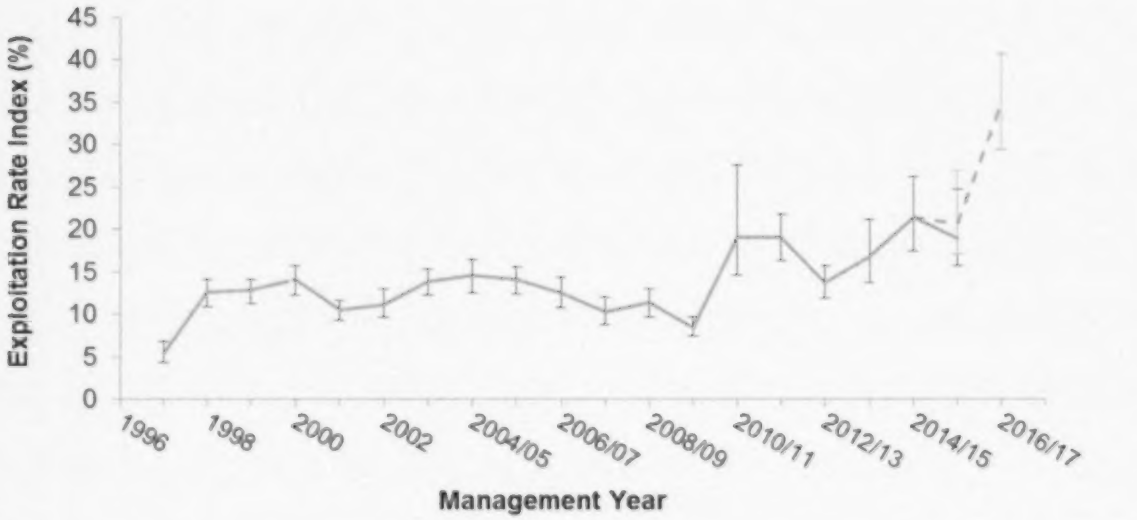

Figure 4. SFA 6 Exploitation rate index based on total catch/fishable biomass index from the previous year, expressed as a percentage. Error bars indicate 95% confidence intervals. The 2015/16 value is based on catch as of February 10, 2016 CAQR. The dashed line indicates 2015/16 exploitation rate index if the TAC is taken and the 2016/17 exploitation rate index should the 48,196 t TAC be maintained and taken.

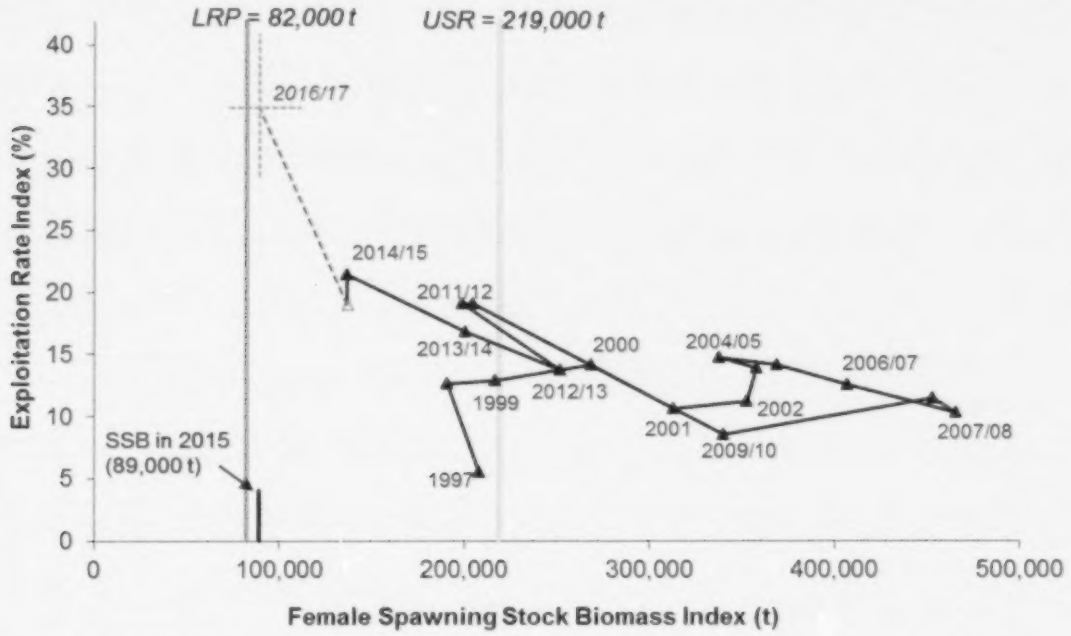

Figure 5[8]. SFA 6 IFMP Precautionary Approach framework with trajectory of exploitation rate index versus female SSB index. Data point labels denote management year. The 2015/16 fishery was ongoing; therefore the 2015/16 point is preliminary. The red cross indicates 95% confidence intervals for the fall 2015 female SSB index (horizontal line) and projected exploitation rate (vertical line), should the 48,196 t TAC be maintained and taken in the 2016/17fishery.

SFA 5 (Hopedale and Cartwright Channels)

Figure 6. SFA 5 historical Northern Shrimp catches and TACs for the period 1976-2015/16 (2015/16 catches are preliminary as of February 10, 2016). In 2003 the management year changed from a calendar year to a fiscal year.

[8] Erratum: May 2016. Figure updated.

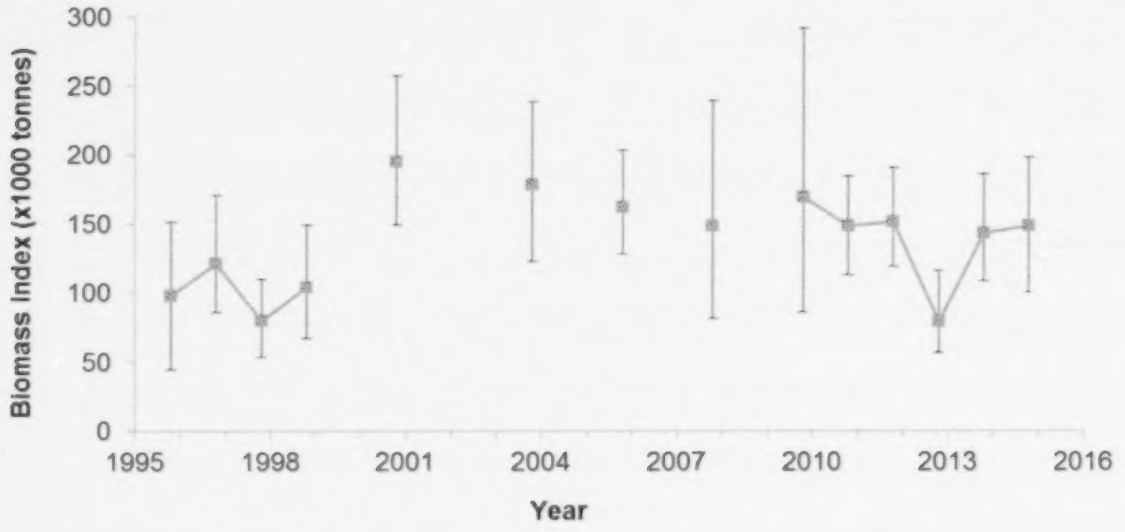

Figure 7. SFA 5 fishable biomass index. Error bars indicate 95% confidence intervals.

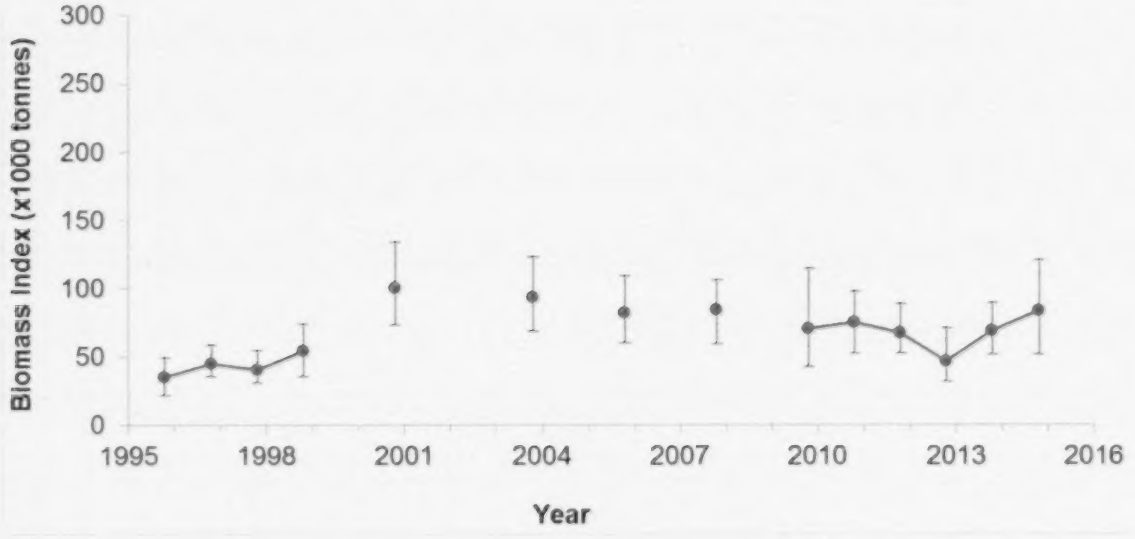

Figure 8. SFA 5 female SSB index. Error bars indicate 95% confidence intervals.

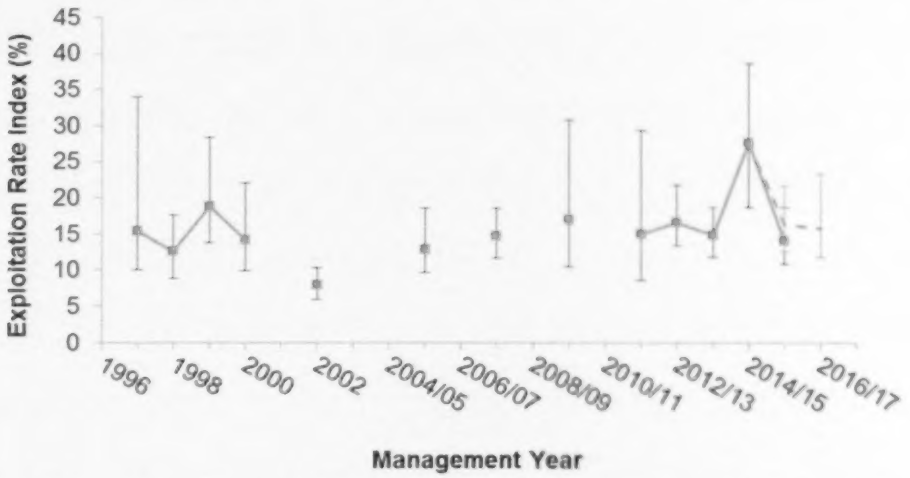

Figure 9. SFA 5 Exploitation rate index based on total catch/fishable biomass index from the previous year, expressed as a percentage. Error bars indicate 95% confidence intervals. The 2015/16 value is based on catch as of February 10, 2016 CAQR. The dashed line indicates 2015/16 exploitation rate index if the TAC is taken and the 2016/17 exploitation rate index assuming the 23,200 t TAC will be maintained and taken.

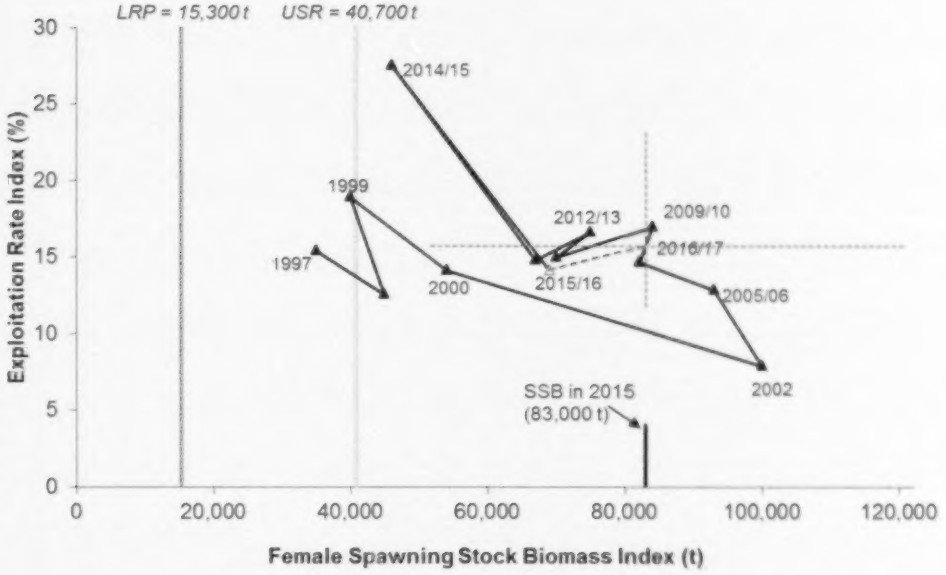

Figure 10[9]. SFA 5 IFMP Precautionary Approach framework with trajectory of exploitation rate index versus female SSB index. Data point labels denote management year. The 2015/16 fishery was ongoing; therefore the 2015/16 point is preliminary. The red cross indicates 95% confidence intervals for the fall 2015 female SSB index (horizontal line) and projected exploitation rate (vertical line), assuming that the 23,300 t TAC is maintained and taken in the 2016/17 fishery.

[9] Erratum: May 2016. Figure updated.

SFA 4 (NAFO Division 2G) *Pandalus borealis*

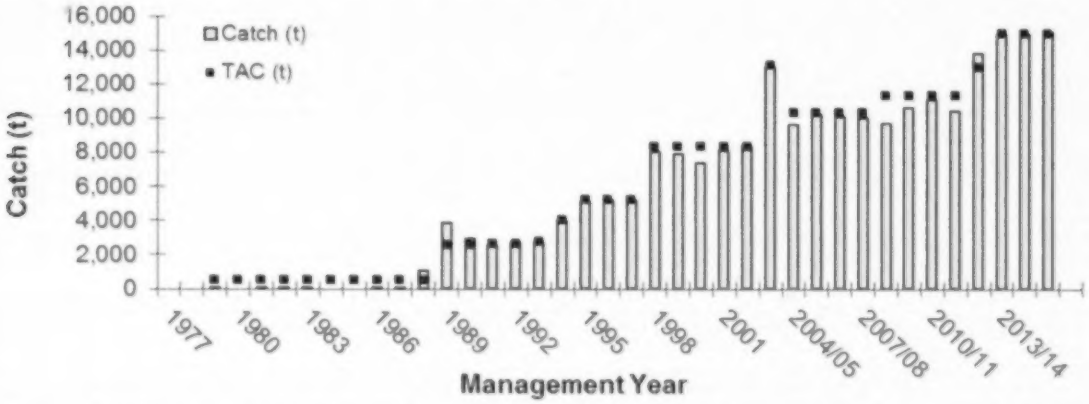

Figure 11. SFA 4 historical Northern Shrimp catches and TACs for the period 1977-2015/16 (2015/16 catches are preliminary as of February 10, 2016). In 2003 the management year changed from a calendar year to a fiscal year.

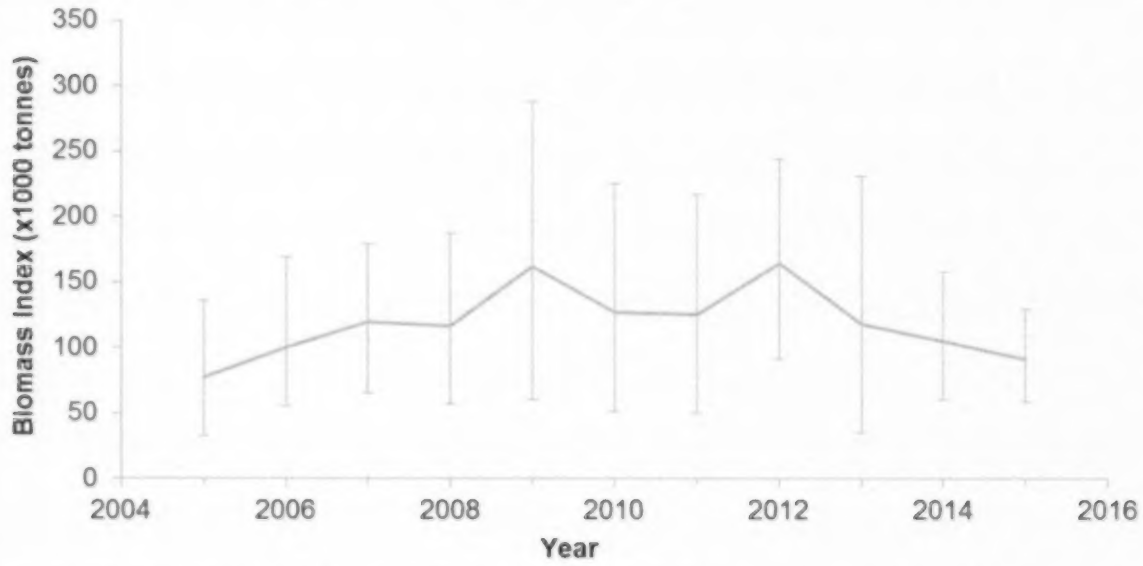

Figure 12[10]. SFA 4 Pandalus borealis *fishable biomass index. Error bars indicate 95% confidence intervals.*

[10] Erratum: May 2016. Figure updated.

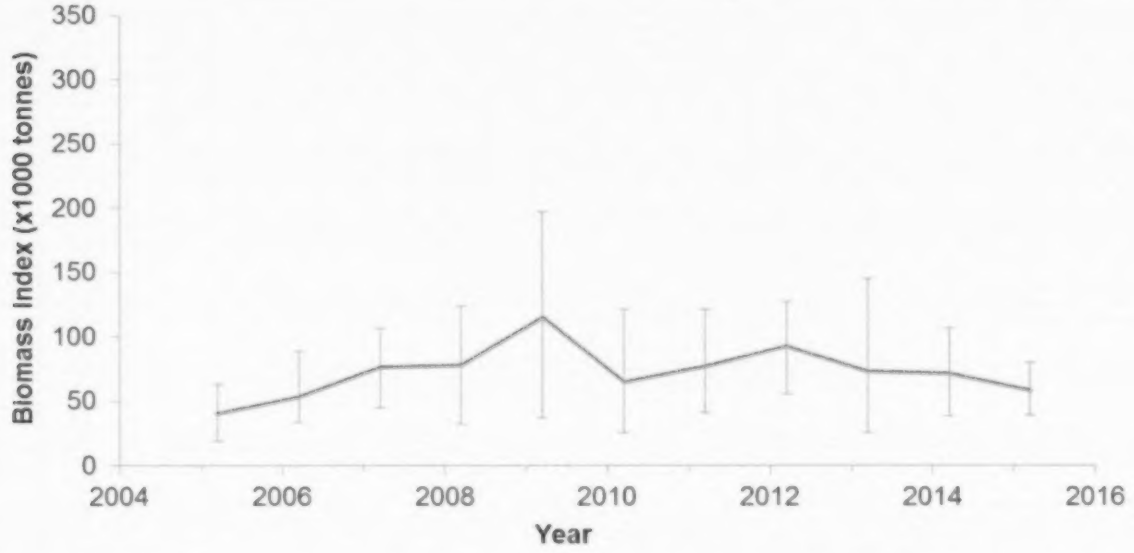

Figure 13[11]*. SFA 4* Pandalus borealis *female SSB index. Error bars indicate 95% confidence intervals.*

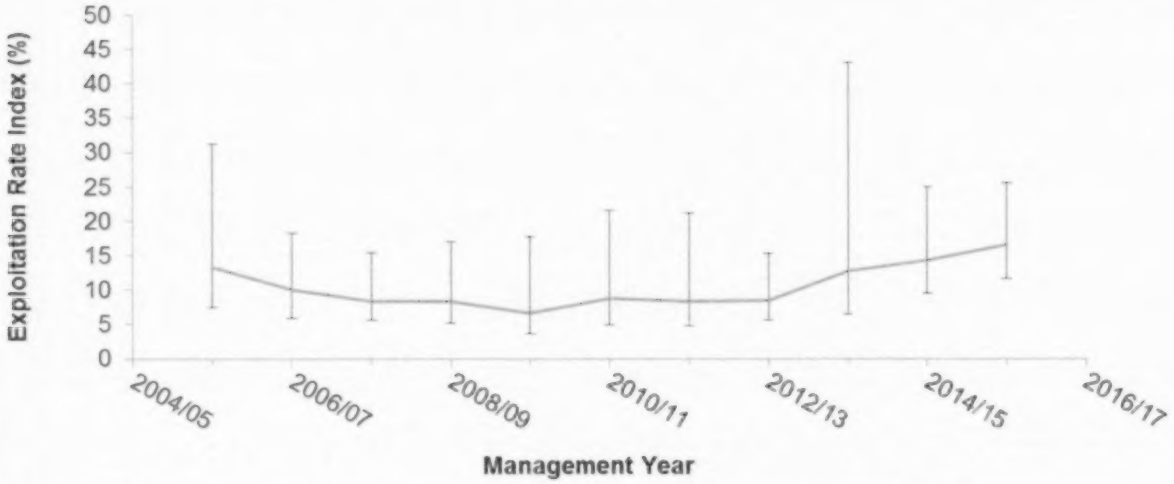

Figure 14[12]*. SFA 4* Pandalus borealis *Exploitation rate index based on total catch/fishable biomass index from the same year, expressed as a percentage. Error bars indicate 95% confidence intervals. The 2015/16 value is based on the February 10, 2016 CAQR, at which time the TAC had been taken.*

[11] Erratum: May 2016. Figure updated.
[12] Erratum: May 2016. Figure updated.

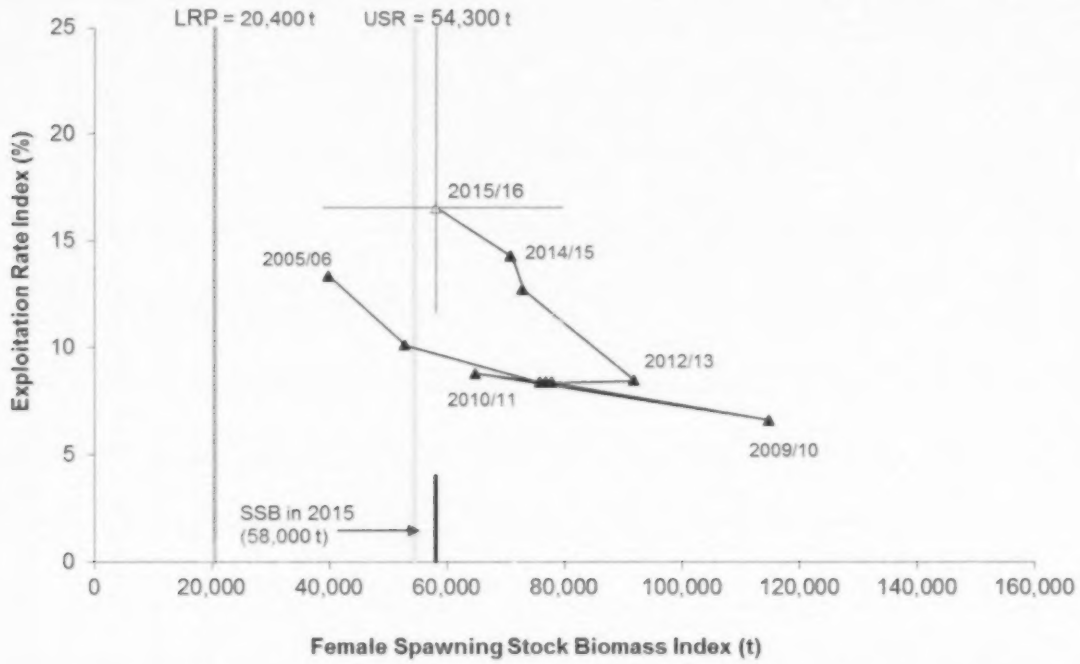

Figure 15[13]*. SFA 4* Pandalus borealis *IFMP Precautionary Approach framework with exploitation rate index versus female SSB index. Data point labels denote management year. The 2015/16 fishery was ongoing; therefore the 2015/16 point is preliminary. However, the TAC had been taken and that point is based on a catch of 15,065 t (101% of the TAC). The red cross indicates 95% confidence intervals for the summer 2015 female SSB index (horizontal line) and the 2015/16 exploitation rate index (vertical line).*

SFA 4 (NAFO Division 2G) *Pandalus montagui*

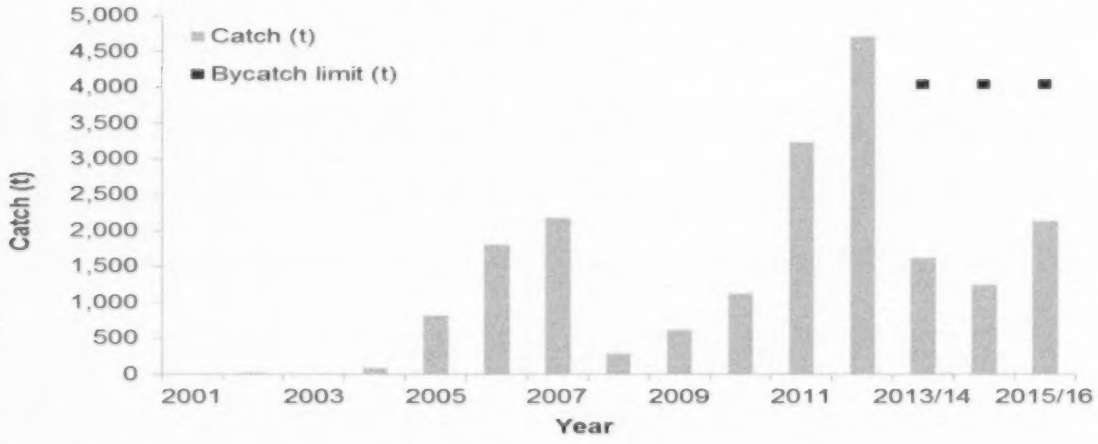

Figure 16. SFA 4 historical Pandalus montagui *catches and by-catch quotas for the period 2001–2015/16 (2015/16 catches are preliminary as of February 10,* 2016).

[13] Erratum: May 2016. Figure updated.

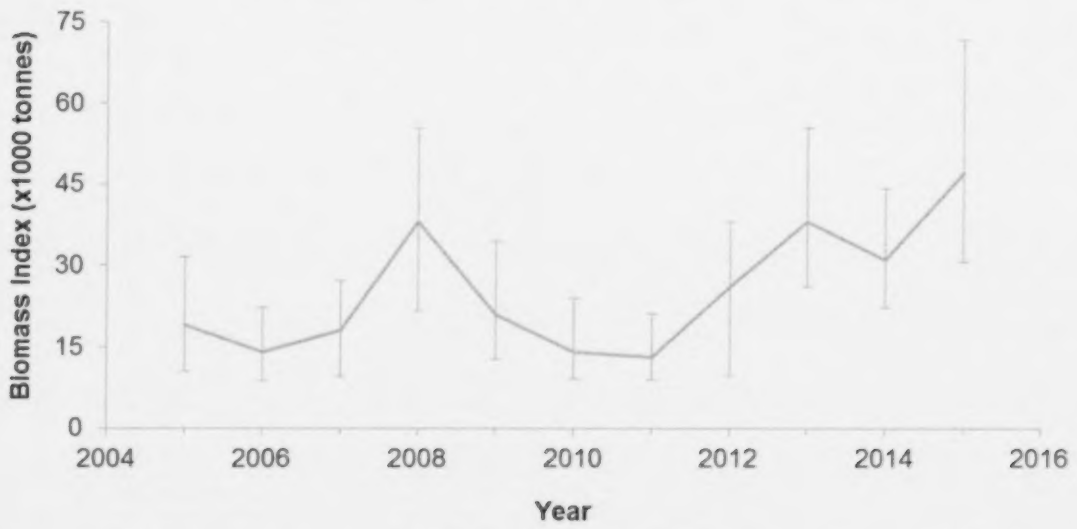

Figure 17[14]*. SFA 4 fishable biomass index for* Pandalus montagui*. Error bars indicate 95% confidence intervals.*

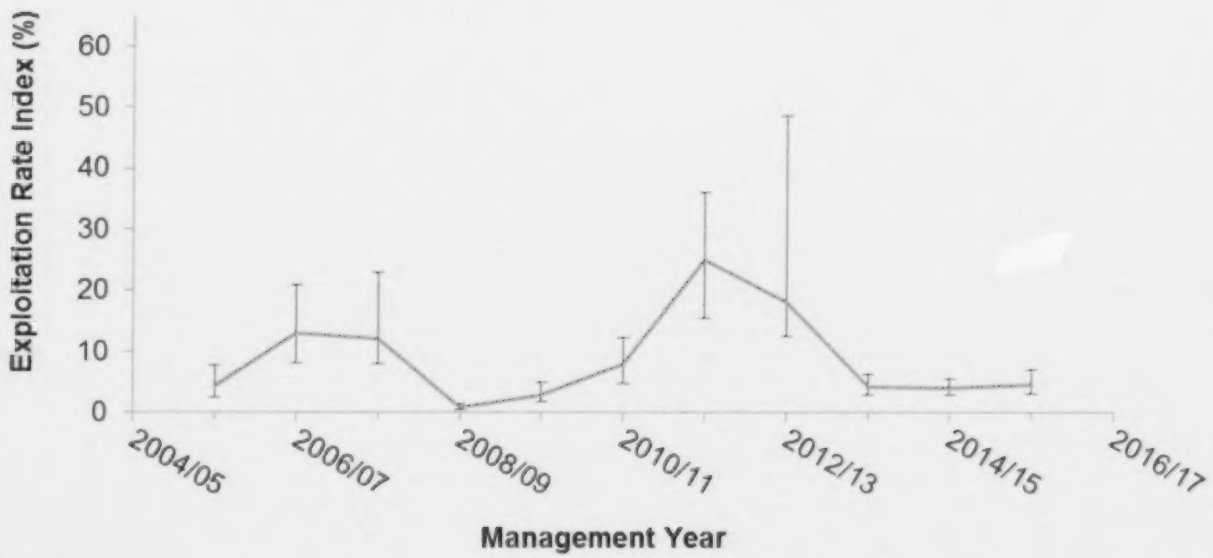

Figure 18[15]*. SFA 4* Pandalus montagui *exploitation rate index based on total catch/fishable biomass index from the same year, expressed as a percentage. Error bars indicate 95% confidence intervals. The 2015/16 value is preliminary.*

[14] Erratum: May 2016. Figure updated.
[15] Erratum: May 2016. Figure updated.

Appendix 2: Tables

Table 1. Biomass indices for Pandalus borealis *in SFA 6.*

Survey Year	Fishable Biomass Index Lower 95% Confidence Interval (x 1000 tonnes)	Fishable Biomass Index (x 1000 tonnes)	Fishable Biomass Index Upper 95% Confidence Interval (x 1000 tonnes)	Female Spawning Stock Biomass Index Lower 95% Confidence Interval (x 1000 tonnes)	Female Spawning Stock Biomass Index (x 1000 tonnes)	Female Spawning Stock Biomass Index Upper 95% Confidence Interval (x 1000 tonnes)
1996	308	383	485	161	208	275
1997	329	367	426	163	191	228
1998	361	399	452	192	217	249
1999	402	448	513	240	269	312
2000	451	498	566	276	313	374
2001	463	541	626	286	353	411
2002	465	514	582	322	358	411
2003	472	530	620	294	338	405
2004	479	530	602	330	369	427
2005	525	603	698	344	407	484
2006	674	785	916	395	466	550
2007	575	653	768	396	453	537
2008	469	537	614	284	340	400
2009	223	323	421	142	205	264
2010	274	313	365	167	199	236
2011	370	425	488	215	252	293
2012	279	351	429	163	201	247
2013	177	217	266	105	137	167
2014	179	233	282	109	137	167
2015	118	138	164	73.1	89.0	111

Table 2. Biomass indices for Pandalus borealis *in SFA 5.*

Survey Year	Fishable Biomass Index Lower 95% Confidence Interval (x 1000 tonnes)	Fishable Biomass Index (x 1000 tonnes)	Fishable Biomass Index Upper 95% Confidence Interval (x 1000 tonnes)	Female Spawning Stock Biomass Index Lower 95% Confidence Interval (x 1000 tonnes)	Female Spawning Stock Biomass Index (x 1000 tonnes)	Female Spawning Stock Biomass Index Upper 95% Confidence Interval (x 1000 tonnes)
1996	44.5	98.0	151	22.0	35.0	49.3
1997	86.0	121	171	35.9	45.0	58.9
1998	53.2	80.0	110	31.1	40.0	55.0
1999	66.8	104	149	36.0	54.0	74.3
2000	-	-	-	-	-	-
2001	149	195	257	73.1	100	134
2002	-	-	-	-	-	-
2003	-	-	-	-	-	-
2004	123	178	238	68.9	93.0	123
2005	-	-	-	-	-	-
2006	128	162	203	60.4	82.0	109
2007	-	-	-	-	-	-
2008	82.6	148	239	59.3	84.0	106
2009	-	-	-	-	-	-
2010	86.1	169	292	42.9	70.0	115
2011	113	148	184	52.2	75.0	98.1
2012	119	151	190	52.6	67.0	88.3
2013	56.3	79.0	116	32.0	46.0	70.6
2014	108	143	186	51.7	69.0	89.5
2015	100	148	198	51.7	83.0	121

Table 3[16]*. Biomass indices for* Pandalus borealis *in SFA 4.*

Survey Year	Fishable Biomass Index Lower 95% Confidence Interval (x 1000 tonnes)	Fishable Biomass Index (x 1000 tonnes)	Fishable Biomass Index Upper 95% Confidence Interval (x 1000 tonnes)	Female Spawning Stock Biomass Index Lower 95% Confidence Interval (x 1000 tonnes)	Female Spawning Stock Biomass Index (x 1000 tonnes)	Female Spawning Stock Biomass Index Upper 95% Confidence Interval (x 1000 tonnes)
2005	32.8	77.0	136	18.8	40.0	63.3
2006	55.3	100	169	33.2	53.0	88.5
2007	64.9	120	179	45.2	76.0	107
2008	56.9	116	187	31.6	78.0	124
2009	60.2	162	288	36.8	115	197
2010	51.5	127	225	25.1	65.0	121
2011	49.5	125	217	40.8	77.0	121
2012	90.9	164	244	55.2	92	127
2013	34.8	118	231	25.2	73.0	145
2014	59.9	105	158	38.3	71.0	107
2015	58.9	91.0	129	38.9	58.0	79.5

Table 4[17]*. Fishable biomass indices for* Pandalus montagui *in SFA 4.*

Survey Year	Fishable Biomass Index Lower 95% Confidence Interval (x 1000 tonnes)	Fishable Biomass Index (x 1000 tonnes)	Fishable Biomass Index Upper 95% Confidence Interval (x 1000 tonnes)
2005	10.4	19.0	31.6
2006	8.7	14.0	22.2
2007	9.6	18.0	27.3
2008	21.5	38.0	55.3
2009	12.7	21.0	34.4
2010	9.1	14.0	23.9
2011	9.0	13.0	21.1
2012	9.7	26.0	38.1
2013	26.1	38.0	55.4
2014	22.3	31.0	44.2
2015	30.6	47.0	71.7

[16] Erratum: May 2016. Table updated.
[17] Erratum: May 2016. Table updated.

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